ANZAM
AUSTRALIAN & NEW ZEALAND
ACADEMY OF MANAGEMENT

RESEARCH ARTICLE

A comprehensive and systematic literature review on the employee attendance management systems based on cloud computing

Afshin Ardebili[1], Ahmad Latifian[2]* iD, Chya Fatah Aziz[3], Rima H. BinSaeed[4], S. M. Alizadeh[5] and Evgeniy V. Kostyrin[6]

[1]Department of Management, Universiti Putra Malaysia, Serdang, Malaysia, [2]Department of Management, Faculty of Economics and Administrative Sciences, Ferdowsi University Of Mashhad (FUM), Mashhad, Iran, [3]Technical College of Applied Science, Sulaimani Polytechnic University, Kurdistan, Iraq, [4]College of Business Administration, King Saud University, Riyadh, Saudi Arabia, [5]Petroleum Engineering Department, Australian College of Kuwait, West Mishref, Kuwait and [6]Bauman Moscow State Technical University, Moscow, Russia
*Correspondence to author: Ahmad Latifian, E-mail: latifian@um.ac.ir

Abstract

Attendance is critical to the success of any business or industry. As a result, most businesses and institutions require a system to track staff attendance. On the other hand, cloud computing technology is being utilized in the human resource management sector. It may be an excellent option for processing and storing large amounts of data and improving management effectiveness to a desirable level. Hence, this paper examines cloud infrastructures for employee attendance management in which the articles are categorized into three groups. The results show that cloud infrastructure has a significant and positive impact on the management of employee attendance systems. Also, the results reveal that the radio frequency identification authentication protocol protects the privacy of tags and readers against database memory. When references operate properly, they help the people concerned and society by making workplaces more efficient and safer.

Introduction

Punctuality is crucial in numerous businesses since it reflects an employee's discipline and devotion. A company is thought to be able to accomplish more in the dynamic, competitive business environment by having a timely and devoted employee. Phrases such as 'there is not enough time,' 'we are too busy with the company,' 'there is lots of work to do,' etc., are often heard by managers and employees of a company. However, researchers estimated working hours to be very low using field tests. Many believe that online management software can provide effective solutions to such problems. Several multinational companies and government-linked companies use a Human Resources Management System (HRMS) to handle various areas of their organizations. Based on the findings of Dalton and Enz (1987), an issue that organizations encounter is absence. Businesses are thus under pressure to discover a simpler yet more efficient method to handle their workers, allowing them to focus on productivity and offering higher-quality services and products to remain competitive (Dalton & Enz, 1987; Othman, Arif, Abdullah, Yusof, & Mohamed, 2017). In this regard, the company's HRM can evaluate the feasibility of implementing online attendance. Every day, the topic of online attendance based on cloud computing

becomes more attractive and popular. It helps achieve effective results and strategies in the field of employee attendance. In the following, the online attendance is explained clearly and accurately.

As far as we know, attendance taking is a manual process prone to errors and inaccuracies. Employee attendance has previously been tracked manually using a paper-based attendance sheet. The company's management maintains the employees' information and assesses their working hours in this manual method (Shah, Gardas, Narwane, & Mehta, 2021). In broader terms, the management adds working hours to the schedule by entering the functioning time for each week or month on the worker's time card. Calculating attendance records, monitoring employee time shifts, noting every in/out time, and the costly expenditure of paper sheets all waste time (Oo, Oo, Chainan, Thongniam, & Chongdarakul, 2018). As a result, most businesses and institutions require a system to track staff attendance. Precise staff attendance data are critical for sustaining employee oversight and discipline. There are a variety of attendance management systems that use contemporary technology for personal identification, such as cloud computing, Radio Frequency IDentification (RFID), and biometric technologies like fingerprint recognition to improve staff attendance monitoring (Zhang, Chen, & Lin, 2021). The biometric system is used to verify the individual's authorization (Oo et al., 2018; Zhu et al., 2022).

Online attendance software is one of the subsystems of employee relations. This software can influence decisions about the nature of employee participation in organizational matters, observing organizational regulations and costs related to employee turnover rates. On the other hand, work–life conflicts arise when work-related stresses are transferred to one's family environment. If personal life stresses are brought to the workplace, a conflict will be created in life–work relations. Flexible workflows designed in the cloud computing environment can reduce these conflicts (Marín, De Oliveira-Dias, Navimipour, Gardas, & Unal, 2021). As a result, the use of flexible working hours and intensive working days will increase employee productivity and satisfaction and reduce the leaving rate (Yao, Li, Zheng, & Zhang, 2022; Zheng & Yin, 2022). In the following, cloud computing and its structures and applications are examined.

Cloud computing is a computer science technique that has lately emerged as a viable option to shift from a local server to the cloud. Cloud computing is a novel model to deliver secure, dependable, fault-tolerant, scalable, and sustainable computational services via the Internet that has recently emerged in the Information Technology (IT) sector. Infrastructure as a Service (IaaS), Platform as a Service (PaaS), and Software as a Service (SaaS) are examples of these services (Rahmani et al., 2021). The user manages the request on system resources in a computer, particularly for data storage and computation for power systems not connected to a local server. The phrase 'cloud computing' refers to data centers accessible to many people through the Internet (Evizal, 2020). Cloud computing is a system that lets users access any software without having to install it for a set length of time and a set price, all through a single web browser. Cloud computing is based on virtualization and dynamic provisioning of resources like database storage, operating systems, and networking (Yadav & Bhole, 2019). Based on the plight of group enterprise HRM study, a set of HRM info systems based on cloud computing technology is created to research the cloud platforms for HR. This set is utilized in several areas of group business HRM, including organizational management, personnel management, attendance management, salary management, etc. (Lv, Tan, Wang, & Yang, 2018). Figure 1 depicts a cloud computing configuration that may be accessible by any consumer and the management system.

Aim of study

Let's look at the present state of management systems. It can be seen that there are several technologies to utilize, like the Internet of Things (IoT), cloud, and blockchain, but still, the old systems are being utilized (Sadrishojaei, Jafari Navimipour, Reshadi, & Hosseinzadeh, 2021a; Sharma & Aarthy, 2016). Employee attendance management leads to improved general corporate performance and the achievement of particular objectives for any business. Accurate employee
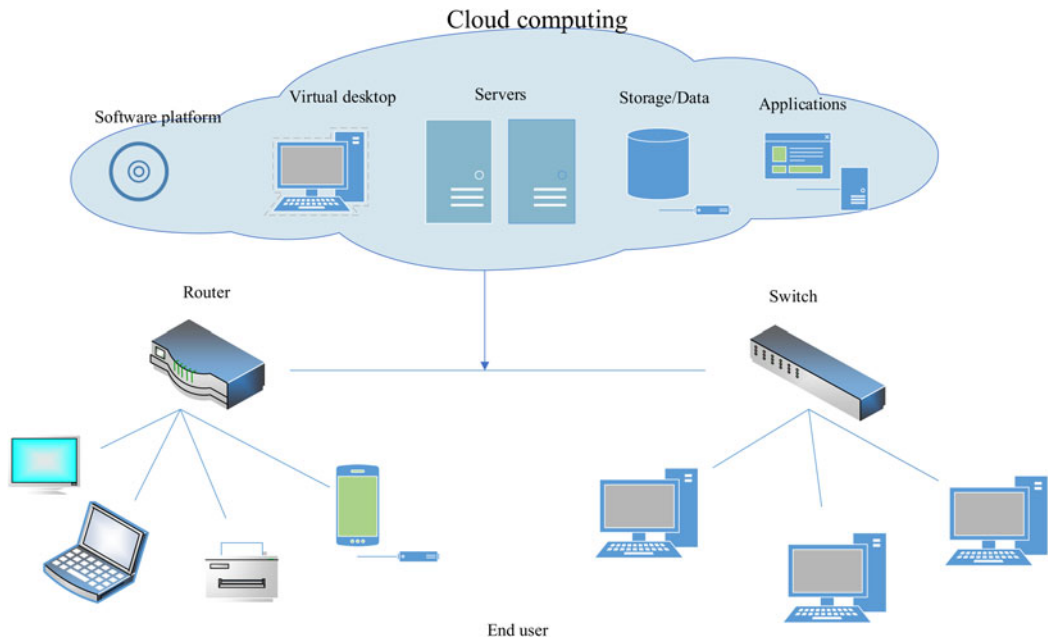
Figure 1. Configuration of cloud computing.

attendance records are critical for maintaining workplace discipline and increasing efficiency. Manual attendance-time checking increases the cost of time-consuming and paper-based work for businesses. Human activities, such as workplace mistakes and fictitious timekeeping, are extra hidden costs that impact the organization's efficiency. Because various firms have varied attendance standards, determining employee working hours is more complicated. As a result, an automated time-attendance management system is one of the most important operational factors for improving productivity and profitability. The time-attendance data are captured by the attendance management system, which is used to keep track of employee working hours. Besides, cloud computing has attracted the attention of factory leaders in recent years because it removes the need for future resource planning and allows businesses to operate without worrying about IT infrastructures like data storage, networks, and servers (Zheng et al., 2022a). The study aims to automate the old method of managing attendance and link the system with the cloud to make all of the data kept by the system easily accessible while decreasing mistakes. Therefore, the paper's main contributions are as follows:

- Automating the old method of managing attendance;
- Using cloud infrastructure in the management of employee attendance systems;
- Helping reduce employee absence and increase the efficiency of organizations.

Ultimately, this paper's layout is as follows. The methodology of the article is explained in the next section. The third section provides the literature review. Then, the section related to the discussion and challenges is presented. Ultimately, the last section concludes the article (see Figure 2).

Methodology

The aims of the WHO Rehabilitation 2030 project were used to guide the techniques for this study, which utilized the preferred reporting items for systematic reviews technique (Marín

Figure 2. The structure of the paper.

et al., 2021). The papers on online attendance systems, cloud computing, and HRM were identified, selected, analyzed, and evaluated using the Systematic Literature Review (SLR) approach (Zadeh, Bokov, Yasin, Vahdat, & Abbasalizad-Farhangi, 2021). The study approach enabled us to establish what defines the present level of research on the application of cloud computing in HRM, create a novel categorization of the literature, and outline the research plan for the future.

For this purpose, the keywords 'cloud computing,' 'online attendance systems,' and 'employee attendance management' were searched in Google Scholar, Scopus, IEEE, and Sciences direct databases. A total of 67 articles were obtained using searches (see Figure 3). The eight articles obtained were unrelated to our topic and only included keywords. Ten articles were duplications, eight articles were written in a non-English language, five articles were not full-text, four items were books, and nine articles were review papers. Therefore, these articles were deleted, and the full text of 23 articles was read. Of these articles, only 18 related articles were selected. Their analysis will be explained in the next section.

Figure 1 illustrates the number of articles published on our intended subject that have been published in various journals. As illustrated in the chart, 2021 contains the most published papers. IEEE account for the largest contribution of articles.

Besides, the countries in which more than three articles have been published are presented in Table 1. The United States tops the list with 12 pieces. China and Bangladesh are second and third, respectively. Most citations also include articles from the United States and Bangladesh.

Eventually, the author's diagram of the articles is presented in Figure 4. The names written in yellow have submitted newer articles, and the names written in purple are older than the others. Hoque Anamul has also published the highest articles on cloud computing and online attendance systems.

Literature review

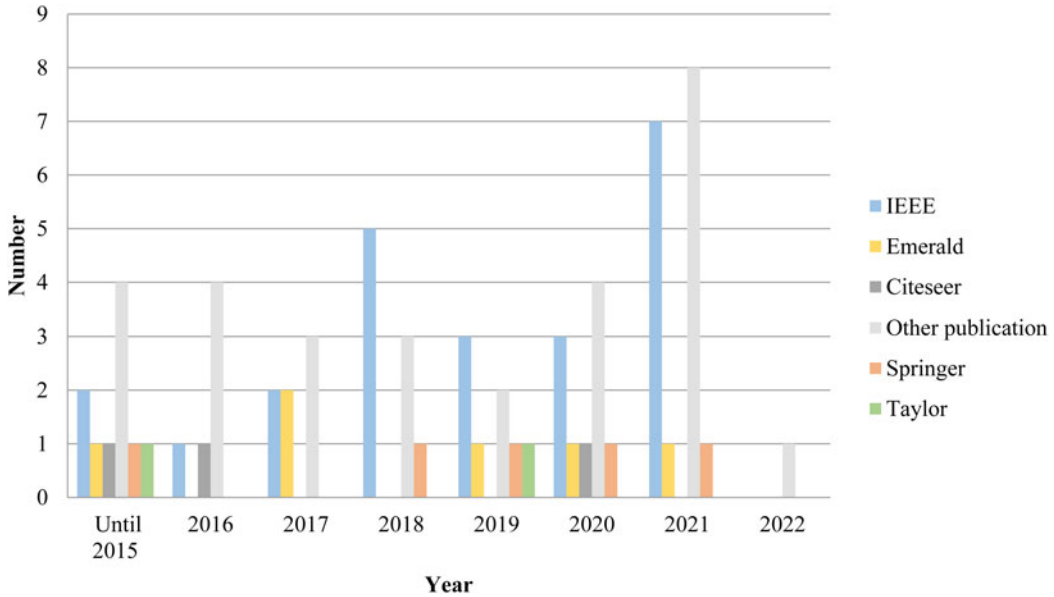This section discusses prior work in online attendance systems, cloud computing, and biometric devices.

Figure 3. Distribution of articles by year and publishers.

Table 1. Countries and the number of articles published in them

Id	Country	Documents	Citations	Total link strength
1	Australia	3	46	3
2	Bangladesh	6	75	8
5	China	7	42	1
10	India	5	1	2
11	Indonesia	3	18	0
24	Saudi Arabia	5	73	7
32	United Kingdom	4	37	1
33	United States	12	78	3
34	Vietnam	3	27	3

Parvathy et al. (2013) provided an overview of connecting RFID with cloud computing to update student attendance and update it in parent, teacher, and staff emails. This system was very beneficial; parents could know that their pupils work shifts every day, reducing the assembly burden at the end of the month. In addition, employees could be well aware of their monthly wages and net hours of work. Direct contact through the promotion of this prototype was not mandatory, as cloud computing helps monitor students' status through the Short Message Service (SMS). Presenting students with unique RFID codes could reduce misconduct and human error when considering current issues. The application of cloud computing could also save HR. Time management was the most efficient benefit to be gained by utilizing cloud computing and RFID.

Dkgoi's & Chincholi (2014) developed an RFID authentication protocol and offered that virtual private network institutions establish a secure back-end channel. It used hashing technology to
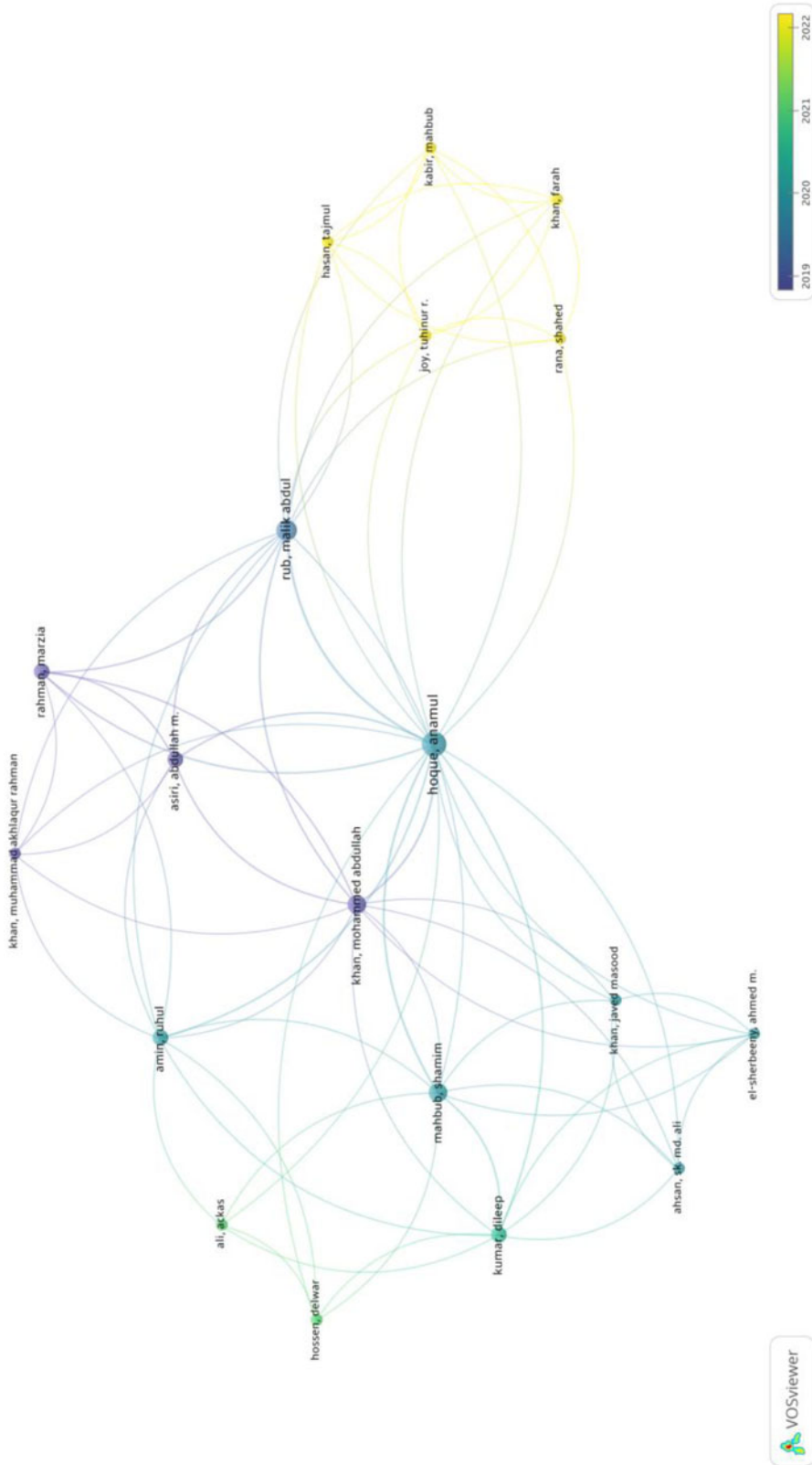
Figure 4. Time overlay distribution of co-authors 2019–Feb2022.

protect the database and provide background communication through a secure channel to protect readers' privacy and tags. The proposed model had the benefits of saving implementation costs, the universality of identity verification, database security, and privacy of mobile reader holders.

Al-Shezawi, Yousif, and AL-Balushi (2017) addressed the execution and design of an automated attendance recording system based on mobile cloud computing. A prototype was presented utilizing Phone Gap and the mobile jQuery model to manage and control student attendance records. Nevertheless, the mobile application was designed to aid pupils in checking the details of their presence, like the number of absenteeism and its percentage. Using Bluetooth technology to automate the student attendance registration process could reduce attendance fraud to attend classes regularly. In addition, cloud-based student attendance registration using Bluetooth addresses would be free since all pupils had smartphones with built-in Bluetooth. The suggested registration system took less time to record student attendance with high accuracy.

Singh, Leavline, and Vijayan (2017) proposed a mobile application for student attendance and performance management system. Its application was designed for the college faculty and other employees who regularly maintain attendance and grades. With this system, subject managers, staff, or authorities could verify the number of students attending or absent from class reunions. The app allowed users to dial attendance and communicate with students via mobile devices. In addition, the application enabled teachers to mark and edit attendance and add the marks to the system database for later retrieval. Once the student's attendance rate was below the specified percentage, it would provide advance instructions to the student through an alert message.

Mittal, Khan, Kumar, and Choudhury (2017) proposed a cloud-based intelligent assistance system through video transmission. The system was based on a relatively large-scale facial recognition concept. The system identified and verified every student in the class. Over this system, this group of students' attendance was completed instantly. Therefore, their system proved more reliable and accurate compared to other alternatives for attendance dialing. Considering the scope of making it a commercial product in the future, the system was integrated into an easy-to-access private cloud, making it more reliable.

Rajeswari, Raju, Ashour, and Dey (2017) suggested a cloud-based multi-fingerprint unimodal-based biometric authentication system. The recommended system architecture introduced a novel fingerprint-based biometric security system concept. It automates matching two human fingerprints, which are routinely employed in biometrics to recognize and authenticate an individual's identification. The suggested system included a novel security architecture in which users were required to give multiple [two] biometric fingerprints throughout service registration. These templates are kept on the cloud service provider's end. Users were verified using these fingerprint templates, which had to be submitted in the order of randomly produced digits each time. For further protection, fingerprint templates and photos were given encrypted wherever possible. Compared to single-fingerprint and manual-based attendance management systems, the suggested multi-fingerprint solution attained 98% precision.

As a case study of problem-based learning and development, Munie Kitchen Cafeteria (a local university cafeteria) was chosen as a stakeholder. Previously, Munie Kitchen Cafeteria implemented a manual system, which recorded attendance using an attendance card and manually calculated wages through the attendance card. It took a long time to calculate employees' wages manually. It was not easy to manage the different working hours of various employees (full-time, part-time, and brokers) with varying work schedules. Therefore, Othman et al. (2017) proposed a network-based cloud HRMS called iHRMS. The system was developed and provided as SaaS, and its functionality was certified by the management of Munie Kitchen Cafeteria. iHRMS was designed to organize and semi-automate employee management in various ways, including the ability to handle labor distribution, scheduling, employee attendance records, and payroll automation.

Utilizing Near Field Communication (NFC) technology, Oo et al. (2018) created a cloud-based employee attendance management solution. Attendance records recorded via NFC, permit and

overtime verification, automatic time computation, real-time access to updated information, working time evaluation, and report creation are included in the suggested system. The suggested solution also included an Internet gateway; numerous user accounts for different companies, no specific software installation, and more flexible data storage. The user satisfaction survey revealed that the suggested solution was utilized and appreciated.

Kumar, Haripriya, and Murikipudi (2018) concentrated on creating a biometric attendance and cloud system with a web-based real-time remote monitoring android application. The system logged the entire attendance percentage of the pupil in each faculty hour in the cloud after satisfactory attendance marking. The same thing happened with the Android apps for worldwide access. Another innovation was the ability for pupils to access digital notes through their mobile application, allowing them to study even if they were absent. The android application has one additional feature that allows the professor to enter the student's grades, marks, and notifications. The pupil could only check his grades via his Android app.

Masruroh, Fiade, and Julia (2018) proposed a mobile assistance system with NFC and facial authorization to add security functions using Raspberry Pi and provide the possibility of storing data in the cloud. They first reviewed related work in time attendance management, NFC, facial authorization, microcomputers, and cloud storage. Then they presented their methodology and design of the structure and scheme of the system. The result was a system that reduced the use of paper and eliminated the loss of time and effort in attendance through a mobile device-based attendance system.

Based on the IoT paradigm, Yadav and Bhole (2019) developed a prototype of a cloud-based end-to-end intelligent attendance system that attempts to generate attendance records and alerts for different stakeholders in educational institutions. To reduce the total time required for classroom attendance, the assistive device adopted a portable design to be easily distributed among students to mark their attendance. The system was tested, and the results were encouraging, which prompted further research and investigation in this field.

The system proposed by Ahirao and Michael (2019) aimed to develop a mobile application to dial personal assistance and thus monitor it automatically. Their investigation proposed a system to mark their presence for college students. The suggested mobile application included a hardware scanner that scans pupils' fingerprints and stores their information in Google Cloud Firebase. Students could also view their attendance records and arrears through mobile phones. Another system user was the teacher, who could update the student's record using the app. The attendance rate of the corresponding subject would be marked, and the corresponding change would be reflected in the student's application. Existing power problems were eliminated through this system. The application was designed to generate a list of defaulters and display a notification to students a week before defaulters were displayed.

Zhang, Feng, Liu, Guo, Krishnamoorthy, and Zhang (2019) proposed a cloud-based automatic class attendance system, a class attendance system based on cloud computing face detection and recognition. Students only needed to stand in front of the camera for a few seconds to complete and log in. The data could be stored in a local or central database. Their system helped teachers improve the efficiency of the student list in the classroom. In addition, students could focus more on the teaching content instead of spending some time going through the check-in form. They found that the application was flexible and reliable and achieved a 100% recognition rate in real-time.

Lin and Chang (2019) developed the beacon attendance system, an intelligent employee management system based on Bluetooth. The Beacon attendance system combined mobile applications and Bluetooth low energy consumption with Beacon technology to quickly store the attendance data of community service personnel in the cloud system. Users could enter and exit work regularly or work overtime every time they commute. Just the mobile app was required to be utilized. After introducing the beacon attendance system, the system could identify employees, automatically calculate the total attendance time, and import the aggregate attendance information into the Enterprise Resource Planning (ERP) system when calculating the employee's

current monthly salary. The results showed that by accessing data in the cloud system, users of the beacon attendance system could automatically calculate employee salaries based on attendance, reducing the time and cost required to perform tasks manually.

Salman, Uddin, Acheampong, and Xu (2019) concentrated on designing and executing a Raspberry Pi-based face detection and identification system. Using image processing techniques, the system analyzed, detected, and recognized faces in student photos. Face detection was done with Haar's cascade classifier technique, while face recognition was done with the local binary pattern histogram approach. After gathering the image processing data, the system created the ultimate attendance record and sent it to the cloud server. A Python-based web framework was used to execute the cloud server. The registry might be accessed remotely through the Internet using an easy-to-use web application. Eventually, the system might send instructors and pupils email alerts with final data at a predetermined time. The findings revealed that his system's efficiency was boosted.

The integration of the fingerprint system and real-time employee assistance was designed to provide data accuracy for Chozzy (2020) salary calculations. It used the service installed on the local server linked to the attendance machine to integrate the data from the attendance machine into the HR system. Every minute, the service collected data and delivered it to the web-server. The Java programming language was used to conduct these services. These services were controlled using representational state transfer technology's application programming interfaces. Based on an average performance assessment of 4.73, the study findings showed that the service could solve the real-time data assistance issue between the machine and the HR system. It provided more secure real-time data accessibility.

Naen, Adnan, Yazi, and Nee (2021) recommended developing a biometric-based attendance management system. A biometric-based attendance management system was designed as a result. This method employed a fingerprint device to collect attendance electronically, and the records were stored in a database. Attendance is taken when students have been identified. A component of the system with AI was also envisioned. The method helped with mistake minimization and more efficient attendance data compilation.

The attendance management system was introduced to replace the manual marking system used by Dhandapani, Majji, Udata, and Manigandan (2022). Text recognition was employed to scan and analyze the ID card and facial recognition on demand. The ID card was scanned, and text recognition was used to compare the pupil's information to the pupil database. It also collects the picture of the person operating and the image stored in the database to avoid proxy attendance. The Nanonets cloud services were used for text recognition. To construct an Application Program Interface (API) demand for facial recognition, prominent cloud services such as Amazon Web Services (AWS) were used. Nevertheless, before submitting this image to a cloud service for analysis and identification of faces, it first utilizes open-source computer vision, a library of programming methods for image processing and determining whether or not a face is present in a particular image database. When compared to similar systems, the execution findings revealed improved performance.

Results from previous studies

Eighteen articles were analyzed in this section. The results will be discussed in the next part. A biometric identifier is a physical or behavioral characteristic of a person. This technology represents a unique method of identifying people. Characteristics are shown in Figure 5. Physiological features are based on measurements (fingerprints, iris, facial recognition, hand geometry) and behavioral characteristics (signature scan, key scan, voice recognition) (Opris, Eftimie, & Racuciu, 2016).

Many businesses, including merchants and government organizations, have been experimenting with biometrics in recent years. In this study, according to the literature analysis, it is found that new technologies such as fingerprint technology, face recognition, and mobile applications
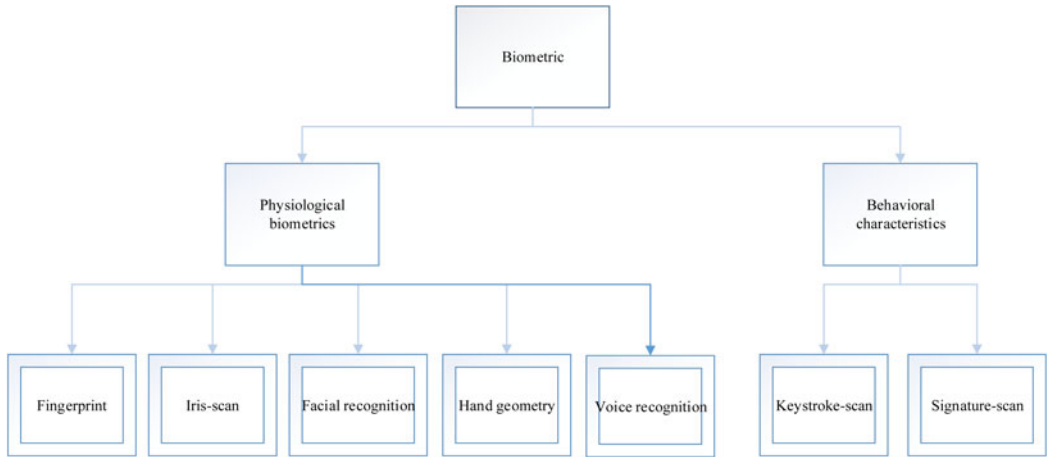
Figure 5. Physiological and behavioral characteristics.

like Bluetooth are the main technologies used for online attendance based on cloud computing. Therefore, in Table 2, the articles of each category are classified; then, each category is briefly introduced.

Face recognition

As one of the most effective images for understanding and analysis applications, facial recognition has garnered a lot of attention, particularly in recent years. At least two factors may explain this tendency: the vast range of commercial and law enforcement uses and the availability of viable technology after 30 years of study. Besides a wide range of practical applications like bank card recognition, police photo searches, access control, security monitoring, and surveillance systems, facial recognition is also a fundamental human behavior required for appropriate interaction and communication (Tolba, El-Baz, & El-Harby, 2006). A formal method of classifying faces was first proposed by Galton (1889). He recommends that face features be collected as curves, a norm is found, and then other profiles are classified based on divergence from the norm. Progress has been made to the point that real-world demonstrations of face recognition systems are taking place. The fast advancement of face recognition may be attributed to several variables, including active algorithm research, the availability of huge databases of facial pictures, and techniques for assessing the effectiveness of facial recognition algorithms (Kortli, Jridi, Al Falou, & Atri, 2020). Although today's machine identification systems have attained a certain level of maturity, the circumstances imposed by several actual applications limit their success. Recognizing face pictures taken in an outside setting with illumination and/or posture variations, for instance, is still a mostly unresolved challenge. In other words, the existing technology falls well short of human perception systems' capabilities. Mobile face recognition is a significant application, thanks to the fast development of mobile devices and the exponential expansion of mobile applications. Besides, mobile devices suffer several resource constraints, including limited processing power, battery life, bandwidth, and storage (Kortli et al., 2020; Sadrishojaei, Navimipour, Reshadi, & Hosseinzadeh, 2021b). Mobile cloud computing was proposed as a viable solution for mobile services. It addresses mobile resources by moving data processing and storage from mobile devices to the cloud. Mobile cloud computing provides rich computing capabilities that can be easily leveraged. Furthermore, as mobile and cloud computing become more commonly accessible, face recognition applications for security and surveillance can profit from the collaborative coupling of the two technologies (Soyata, Muraleedharan, Funai, Kwon, & Heinzelman, 2012).

Table 2. Summary of the specifications of the analyzed articles

Authors and year	Application	Technique	Advantages
Parvathy et al. (2013)	Mobile applications	■ A providing of connecting RFID with cloud computing	■ Reducing misconduct and human error ■ Saving HR ■ Time management
Dkgoi's and Chincholi (2014)	Mobile applications	■ Developing an RFID authentication protocol	■ Saving implementation costs ■ The universality of identity verification ■ High database security ■ High privacy of mobile reader holders
Al-Shezawi, Yousif, and AL-Balushi (2017)	Mobile applications	■ Phone Gap and the mobile jQuery model	■ Reducing the time ■ Increasing accuracy
Singh, Leavline, and Vijayan (2017)	Mobile applications	■ Sun Java wireless toolkit with Java platform, micro edition	■ Increasing accuracy
Othman et al. (2017)	Mobile applications	■ A network-based cloud iHRMS	■ The ability to handle labor distribution ■ Recording accurate scheduling ■ Recording employee attendance records ■ payrolling automation
Oo et al. (2018)	Mobile applications	■ NFC technology	■ Real-time access to updated information ■ Working time evaluation and report creation ■ Storing more flexible data
Kumar, Haripriya, and Murikipudi (2018)	Mobile applications	■ An integrated biometric attendance and cloud system with web-based real-time remote monitoring android application	■ Marking of the attendance ■ The accessibility of digital notes to students ■ The faculty could enter the student's grades or marks and notices by the proposed system.
Masruroh, Fiade, and Julia (2018)	Mobile applications	■ RaspberryPi system	■ Reducing the use of paper ■ Eliminating the loss of time and effort in attendance
Ahirao and Michael (2019)	Mobile applications	■ Google Cloud Firebase application	■ Automating the marking of individual attendance ■ Remote monitoring
Lin and Chang (2019)	Mobile applications	■ Intelligent employee management system based on Bluetooth	■ Reducing the time ■ Reducing the cost
Mittal et al. (2017)	Face recognition	■ Visual C and MATLAB method and Jones Algorithm	■ Increasing accuracy ■ High reliable

(Continued)

Table 2. (*Continued.*)

Authors and year	Application	Technique	Advantages
Zhang et al. (2019)	Face recognition	■ A local or central database system	■ High flexible ■ High reliable ■ High recognition rate in real-time
Salman et al. (2019)	Face recognition	■ Face recognition ■ Haar's cascade classifier technique	■ Remote monitoring ■ Facilitating the identification of students and teachers
Dhandapani et al. (2022)	Face recognition	■ Programming functions	■ Increasing data accuracy ■ Helping enroll students
Rajeswari et al. (2017)	Fingerprint	■ Multi-fingerprint unimodel-based biometric authentication model	■ Increasing data security ■ Increasing data accuracy
Yadav and Bhole (2019)	Fingerprint	■ A cloud-based intelligent attendance system based on the IoT paradigm	■ Reducing the time
Chozzy (2020)	Fingerprint	■ The Java programming language	■ Increasing data security ■ Increasing data accuracy
Naen et al. (2021)	Finger print	■ Artificial intelligence	■ Redacting of errors ■ The more effective compilation of attendance data

Mobile applications

Mobile applications are a rapidly growing part of the global mobile market in today's technologically advancing world. Mobile applications are being developed in Meteor Space to provide users with a rich and fast user experience (Golhar, Vyawahare, Borghare, & Manusmare, 2016). The combination of mobile devices and cloud computing can create a new mobile cloud computing structure. In mobile cloud computing, data storage and processing are systematically stored outside of the mobile device (Al-Shezawi, Yousif, & AL-Balushi, 2017). Mobile applications overcome the limitations of traditional systems. The mobile application allows users to install time and attendance applications on their mobile devices. By linking their cellphones to a server that holds attendance and calling records over the Internet, consumers may update employee attendance and dialing details in the local mobile database. Therefore, you can view updated scores and attendance details offline (Singh, Leavline, & Vijayan, 2017).

Fingerprint

Fingerprint recognition is a common and efficient approach for a priori approving individuals and securing data during connection (Li et al., 2020). The fingerprint generated by the elevated nipple ridge is the greatest reference for personal identification. Besides, conventional fingerprint identification algorithms suffer from readily losing rich information and poor performance due to complicated inputs like picture rotation, missing input photos, and low image registration quality (Yang et al., 2011). Furthermore, currently available latent fingerprint images are generally low resolution, have low information content, and require several steps for identification. An automatic fingerprint identification system is required. Cloud computing-based fingerprint recognition schemes have replaced traditional methods of ensuring communications security (Rajeswari et al., 2017).

Discussion

The traditional model of employee attendance primarily involves employees filling in schedules manually or using time-stamping machines. This model requires employees to queue to register, which delays their registration time and sometimes relates to loopholes where employees ask their colleagues to register on their behalf. These shortcomings make calculating employee wages slow and laborious. Additionally, business managers cannot accurately and instantly monitor and manage employee attendance with this traditional model, reducing communication and management efficiency between departments. The popularity of mobile devices, IoT applications, and cloud computing technology has increased cloud-based software and hardware application in numerous industries (Sadrishojaei, Jafari Navimipour, Reshadi, Hosseinzadeh, & Unal, 2022; Sun, Lin, Si, Xu, Li, & Gope, 2022). In addition to traditional time stamping machines, today's time and attendance systems mainly involve passive methods, such as RFID technology, magnetic barcode cards, and proximity access control.

Therefore, this article examines the attendance of employees using cloud computing. Related articles were reviewed, and the results are summarized below. In recent years, with the growth of information technology, very modern devices and systems have been built to help human resources make it more accurate and easier for companies to record personnel traffic. Online attendance system using cloud computing technology and being easily accessible from any place has lower costs than older systems. The online attendance system allows users to access it from any place, at any time, and with any device. Other advantages of this system include the high flexibility of the system in the presence of changes in labor and social security laws, the possibility of calculating salary and benefit factors in various executive methods by the user, accuracy and speed in the calculation, a professional and user-friendly environment,

and 24 h Internet services (He et al., 2022). The strength of online attendance is the use of cloud space instead of local space to store information. In addition to security, it makes it easy to manage, significantly reducing the organization's costs. There is no necessity to pay for hardware or maintenance costs in other cloud systems. Figure 6 summarizes the benefits of cloud computing.

Undoubtedly, all general biometric systems and recognition scanners, such as voice recognition, eye retina, and fingerprints, are the best equipment used. In addition, online attendance systems can be used as a better substitute for biometric devices used in relatively time-consuming online examination systems (Jayant & Borra, 2016; Mittal et al., 2017). Cloud-based online attendance software positively affects the 12 variables in Figure 7. Organizational citizenship behaviors increase by creating a sense of trust between the employee and the employer. Employees become more involved with their jobs, and the employer will feel more satisfied. Therefore, online attendance software is beneficial and vital for those businesses that want to receive the human resources excellence award.

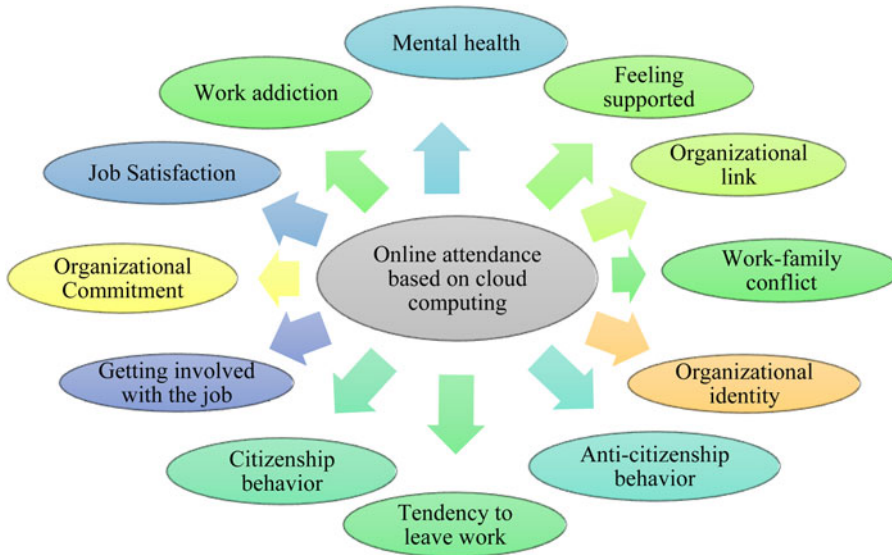**Figure 6.** Advantages of using cloud computing.

Figure 7. The effect of cloud-based online attendance on job and organizational attitudes.

Challenges

Some current time attendance systems have limits in terms of recognition speed, device cost, real-time attendance tracking, and database storage space flexibility. Therefore, this section will examine some of the challenges and provide solutions for future studies.

Cloud services are highly dependent on the network. It is difficult to avoid the negative effects of data leakage, service loss (such as service interruption and service termination), service deterioration, and loss of control (Yan, Yin-He, Qian, Zhi-Yu, Chun-Zi, & Zi-Yun, 2021; Zheng, Zhou, Liu, Tian, Yang, & Yin, 2022b). Ensuring the security of the cloud requires technical improvements and further refinement of the law (Géczy, Izumi, & Hasida, 2012). Besides, a prominent problem in the computerization of HRM is the lack of IT skills of HRM experts. The essential challenge for developers is to convert organized and semi-structured management theories, techniques, and tools into unambiguous IT problem-solving procedures. This job necessitates extensive managerial experience and strong IT abilities such as IoT (Maroli, Narwane, & Gardas, 2021). The inconsistency of these two occurrences results in a scarcity of platform developers.

On the other hand, iHRMS is a diligent method to replace small to medium-sized enterprises and enterprises' traditional employee management systems to manage employee attendance and wages. Most traditional employee management methods cannot grasp employee attendance in real-time, so they cannot track their punctuality. From another perspective, the problem will affect the performance of the employees in the organization. The introduction of iHRMS solves the above problems and helps provide a more accurate payroll system to manage its finances better (Othman et al., 2017).

The time attendance machine is used for time and attendance data information requirements and is not optimal for data integration with the human resources system. Because the attendance data obtaining process from the attendance machine needs to use other applications or download data from the attendance machine via U disk or flash, the information obtained by the time attendance machine must be further processed to turn it into valuable information in the decision-making process (Chozzy, 2020). In addition, some places are slow and unstable; this will significantly reduce the user experience of the cloud service. The popularity of cloud computing depends on the development of the network (Wang, Ramamoorthy, Xi, Rajagopal, Zhang, & Jafari, 2022).

Since RFID is a low-cost device, we can use it in various fields such as transportation, medical treatment, business, and security. Since RFID is now widely used, its combination with the cloud provides a unique platform to explore promising and valuable solutions. The interface between RFID and cloud computing will be more conducive to solving current problems. Technical updates without technical support (Parvathy et al., 2013). The proposed system requires an active Internet connection because it performs real-time attendance input in a cloud database without storing it on the device. Future devices should also operate offline; when there is no Internet connection, it will store the help locally and transfer it to the cloud when connected.

Conclusion and future work

This study examined the role of cloud computing in employees' attendance. Literature on the subject was analyzed. The results showed that this field's most important biometric technologies are fingerprint, face recognition, and mobile applications. The attendance management system is always an important entity for any organization; many attendance systems are already on the market, such as barcodes, RFID, and fingerprint identification systems. Information gathered through time, and attendance management reports help determine if the organization is on the right track and moving toward a successful future. The workforce is a critical resource that companies must know to keep track of their attendance and time. By monitoring attendance, companies can more easily decide which employees are on time, early, or often late. Employees of different organizations were involved in bogus licenses that negatively influenced organizational performance. Therefore, organizations use different types of management methods to maintain the performance of their employees in numerous business organizations. Each company uses different attendance management systems according to its own budget and convenience. Systems designed and adopted rarely have shortcomings, such as data processing, data security, and information privacy (Chen, Liu, Xiang, & Sood, 2021b; Chen, Miao, Chen, Fang, Zeng, & Shi, 2021a). The results show that the cloud computing-based group-level HRM information system can help companies efficiently complete HRM tasks, reduce communication costs, and improve efficiency. Therefore, interconnecting biometrics with cloud infrastructure can improve speed, secure communication, scalability, identity and access management, reliability, and automation.

Research implications

Using the cloud-based technologies, this project intends to expand scientific understanding in the HRM field. Cloud computing is transforming the shape and function of IT platforms as an emergent technology. It enables organizations to innovate cloud-based HRM approaches like fingerprint, mobile applications, and facial recognition to cut costs and increase productivity without compromising their employees' quality of life and well-being (Cheng & Wang, 2022). The study indicates that businesses and supervisors should seek remote working alternatives in all professions whenever feasible to reduce ambiguity and promote employee and student well-being. This research can assist executives in better comprehending how needs, combined with capabilities, might affect the choice to use cloud computing as an HRM restructuring system facilitator. This research adds to our knowledge of how this technology may spread among online attendance.

Like other articles, this article has its limitations, including that only English articles are discussed. Future studies can also use non-English articles and provide a more comprehensive article. They also can discuss other biometric tools based on cloud computing, and IoT can be a suggestion for future work.

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